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Skawina, 1959

# Brief Description of Skawina Power Station

## Introduction

The purpose of this study is to provide conscise information about the Power Station at Skawina, one of the biggest establishments of this kind in the country.

An industrial revolution, taking place in Poland in the post-war years has contributed to the substantial industrialization of the country and has caused a steadily increasing demand for elestric energy both expanding industries and for a large scale electrification of towns and villages. The need for expansion was particularly marked in Southern Poland. In order to remove shortages in this region a decision was made in 1952 to build a high capacity power station at Skawina.

The project envisaged that the power station will have the capacity of 300 MW on completion. However, even at the time of working on this project it turned out that the rate of increase in demand is faster than it was originally assumed. Consequently at the time of approving the preliminary draft of the project in 1954 it has been decided to build the elements of the water and coal supply systems in such a way as to permit an eventual increase in the capacity of the power station on completion to 500 MW.

The final decision was made in 1956. The power station at Skawina was to be build in two consecutive stages. In the first quarter of 1959 it was to reach the capacity of 300 MW, and in the fourth quarter of 1960 the target capacity of 500 MW.

The most characteristic data about the Power Station at Skawina are given below in the following sections:

I. Technical solutions
   a. Main elements of the thermo-mechanical system
   b. The water supply system
   c. The electrical system
   d. General description of the construction of the buildings

II. The history of construction

III. Drawings and diagrams

IV. Photographs

## a/ Main Elements of the Thermo-mechanical System

### The Boiler House Equipment

In the first stage of construction seven fully-radiated two-drum type boilers have been installed. Each boiler is heated by pulverised coal and has a maximum capacity of 230 t/h of steam at pressure 110 kg/cm$^2$ /working pressure 101 kg/km$^2$/ and superheated steam temperature of 510$^{o}$C.

Each boiler is equipped with two ball-mills with intermediate coal powder containers and two ventilators.

Cleaning of fumes takes place in the electrostatic filters having the efficiency of 92 ± 2%.

The first two boilers were supplied by the USSR, the remaining ones by domestic establishments.

Technical data:

| Particulars | Unit | Boiler 1-2 | Boiler 3-7 |
|---|---|---|---|
| Type of boiler | | PK - 10 | OP - 230 |
| Maximum output | t/h | 230 | 230 |
| Allowed pressure | kg/cm$^2$ | 110 | 110 |
| Working pressure | " | 101 | 101 |
| Temperature of superheated steam | Centigrade | 510 | 510 |
| Temperature of water | " | 215 | 215 |
| Efficiency at maximum output | % | 89/87 | 87 |

In the second stage of construction four new boilers of domestic production will be installed. They will be of the type OP-210, allowed pressure 110 kg/cm$^2$ working pressure 101 kg/cm$^2$ and superheated steam temperature of 510$^\circ$C. They will be fully radiated, two-drum type boilers heated by pulverized coal and equipped with three-stage steam superheaters and with air heaters of "Ljungstroma" type.

The choice of the boiler type was influenced by the fact that the power station will supply heating steam and hot water for the industrial establishments in the neighbourhood and for a part of the town.

The Coal Supply System

In principle the power station will be supplied with low-grade coal from the coal basin nearby. The waggons of the "Talbot" type will be used for the transport of coal. The "Talbots" will be emptied into a gap-outlet container and from there coal will go to the boiler house on two conveyor belts.

When the gap-outlet container is full, coal is moved to a reserve store from special unloading pits at the railway siding. A gate-type unloading crane is used for this purpose.

From the store coal is moved by the gate-type crane on the conveyor belt and through the crusher house to the boiler house.

In the second stage of construction the power station will be equipped with a drum type revolving unloading device.

## The removal of slag and ash

The removal of slag and ash will be based on a hydraulic method with the help of "Moskalkow" devices and swamp pumps. Until 1960 both slag and ash will be hydraulically removed through a system of pipes to a dump located about 1800 meters from the power station.

In 1960 the ash removal system will be modernized and dust will be delivered pneumatically to the neighbouring factory of foam-gas-silica products.

## The Treatment of Additional Water Supply

Water treated in the chemical water softening plant is used to replace water losses.

The sequence of treatment is as follows:

1. Decarbonization. Carbon hardness of raw water is removed in rotating reactors wuth the help of calcium-magnesium treatment.
2. Filtering. Decarbonized water is filtered through quartz pressure filters.
3. Softening. Decarbonized and filtered water is softened in sodium exchangers and then degassed.

## Turbine House Equipment

### Turbogenerators

In the first stage of construction two turbo-generators
50 MW ... 100 MW
WK-50-1 and two turbo-generators WK-100-5 /from the USSR/ have been installed, with parameters: steam pressure - 90 kg/cm$^2$; steam temp. - 500°C; temperature of cooling water - 10°C.

In the second stage of construction two more turbo-generators of the WK-100-6 type will be installed.

Generators

The WK-50-1 turbines revolve the 62,5 MVA generators and the WK-100-5 and WK-100-6 turbines revolve the 125 MVA generators. The generators are hydrogen cooled.

## Technical and Economic Data

| | I Construction data | Unit | I Stage 300 MW | II Stage 500 MW |
|---|---|---|---|---|
| 1. | Size of Site | hectares | 34,5 | 36 |
| 2. | Percentage of built up area | % | 37 | 39 |
| 3. | Cubage of the main building with the ventilating romm | $m^3$ | 370.000 | 550.000 |
| 4. | Unit cubage of the main building with the ventilating romm | $m^3$/MW installed | 1230 | 1100 |
| 5. | Unit cubage of all buildings | - " - | 1600 | 1300 |
| 6. | Total cubage of all buildings | $m^3$ | ca 480000 | 664000 |
| 7. | Unit cost of installed capacity in 1959 prices | Złoty/MW installed | 3300000 | 3280000 |
| | **II Exploitation data** /Calculated for the operating time /6500 hours per year/ of the installed capacity/ | | | |
| 8. | Annual gross output of electric energy | TWh | 1,95 | 3,25 |
| 9. | Maximum capacity of auxiliary equipment | KW<br>% | 57879<br>19,3 | 89603<br>17 |
| 10. | Used capacity of auxiliary equipment | KW<br>% | 28480<br>9,5 | 4373<br>8,75 |

| | | | | |
|---|---|---|---|---|
| 11. | Power used annually /7000 hours/ for own needs | TWh | 0,20 | 0,27 |
| 12. | Power produced annually by the hydro-electric plant | TWh | 0,006 | 0,011 |
| 13. | Annual net output of electric energy | TWh | 1,756 | 2,955 |
| 14. | Annual coal consumption in standard coal units | t | 865000 | 1365000 |
| 15. | Unit coal consumption per kWh produced | kg/KWh produced | 0,43 | 0,41 |
| 16. | Unit heat consumption per KWh produced | Kcal/KWh produced | 3010 | 2865 |
| 17. | Unit heat consumption per KWh distributed | Kcal/KWh distributed | 3445 | 3151 |
| 18. | Net efficiency of the power station | % | 28,4 | 30 |
| 19. | Gross efficiency of the power station | % | 31,5 | 33,0 |
| 20. | Employment index | men/MW installed | 3,06 | 1,96 |

b/ The Water Supply System

Assuming the final capacity of the power station to be 500 MW the supply of water needed for an open circulation of a cooling system and for other minor purposes would be about 25 $m^3$/sec.

I. The problem of supplying this amount of water has been solved in the following way:

1. Within the framework of regulating the Wisła river the Water System Development Authority has built a dam in its upper part at Łączany, and a 16 kilometers long navigable channel to Borek Szlachecki. Also at Borek Szlachecki an upper water reservoir has been built, from which on one side a two-chamber sluice enables the passage of barges to the level of a lower channel directly connected with the main bed of the river Wisła, and on the other side a so called "power channel" - about 1 1/2 kilometers long - branches off and supplies water to the power station.

2. The "power channel", built as a part of the power plant, supplies water for the central pumping station N 1.

This solution allows to maintain an appropriate absolute level of water in the inlet chamber before the central pumping station of the plant.

In consequence, and applying at the same time the "lever" principle, the pumps have to overcome only the resistance of flow through the pipes and condensers. This permitted to limit the amount of energy used for pumping to about 4000 kW, in spite of a substantial amount of water.

II. The water disposal system of the plant has been solved in the following way:

1. Water from the condensers goes through the pipes to steel reinforced concrete disposal channels ending with overflows regulating a uniform level of water in the channels, necessary to make the "lever" principle operative.
2. Through the disposal channels water goes to the inlet chamber of a small hydro-electric plant located directly at the outlet.
3. The through flow hydro-electric plant is equipped with a turbine of 1,5 MW and utilizes, on the one hand a substantial amount of water flowing through the condensers of the turbine of the termal power station, and on the other hand a natural difference of water levels in the channels and in the river Skawina to which water is finally disposed of.
4. To avoid excessive cooling of condensers in winter time an additional, so called return channel made of steel reinforced concrete has been built thus permitting the re-circulation of water heated in the condensers back to the inlet chamber before the central pumping station No 1. This water, mixing with steadily flowing cold water, main-

tains in winter time the temperature of 7-8 degrees Centigrade on entering the condensers.

III. The detailed hydrological data for many years showed that unfortunately, in the summer period the amount of water in Wisła is so small that the power station could take for its use only up to 10 $m^3$/sec. Considering this limitation it has been decided to enable the power station to operate in summer time by equipping it with a set of ventilator-type coolers which would allow closed circulation in some turbines in summer time.

IV. To supplement the above information it should be added that:

1. A certain amount of water from the pipes is used for cooling the bearings of all the more essential rotating devices and for cooling hydrogen in the generators and motors of auxiliary pumps.
2. From the outlet channels a certain amount of water is taken for hydraulic decindering and de-ashing.
3. To supplement condenser losses in circulation between boilers and turbines two sources are provided for. The basic source is water from the river Skawinka which is of better quality and is fed through a chemical water-filtering plant. An emergency source is provided by main pipes which through several re-connecting and boiling arrangements can supply water from Wisła to the

chemical water-filtering plant. The treatment in this plant makes it possible to use water - after an appropriate thermal processing and after de-gassing - in the circulation between the boilers and the turbines without any ill-effects.

c/ The Electrical System

There are three basic divisions in electric problems. The first is the transmission of electric power produced by turbo-generators, the second is the supply of power for the internal installations of the power station, the third is the central control room with its operating network.

I. The transmission of electric energy

The power station will transmit electric energy through overhead lines and cables for the currents of 220 kV, 110 kV, 15 kV and 10,5 kV. The 220 kV lines are connected with the nation-wide electric energy supply system. The 110 kV lines are connected with regional electric energy supply systems. The 10,5 and 15 kV lines are connected with local electric energy supply systems.

To meet those requirements internal solutions go along the following lines:

1. The first two turbo-generators each of the capacity of 50 MW and 10,5 kV current are directly connected with the indoor 10,5 kV layout, which has a divided two busbar system and small oil

circuit-breakers: 400 and 1500 MVA.

2. All the remaining four 100 MW and 13,8 kV turbo-generators have block connections through transformers with 110 and 220 kV layouts. The details of connections are given in the Simplified Electrical Diagram.

3. The overhead 110 kV, 19-field layout has a divided two busbar system with supplementary by-pass bus. It has 4000 MVA air circuit-breakers.

4. The overhead 220 kV, 10-field layout has a two busbar system /not divided/ with supplementary by-pass bus. It has 7000 MVA air circuit-breakers.

5. The generator of the hydro-electric plant is connected with the 15 kV layout through a 2 MVA 6/15 kV block transformer.

II. The supply of power for internal installations

1. Own needs of the power station are supplied by currents of 6 kV, 380 V, 220 V.a.c., and 220 V d.c. There are three 10 MVA 10,5/6 kV transformers and one reserve 12,5 MVA, 110/6 kV transformer. Further two 12,5 MVA, 13,8/6 kV transformers are tapped from the connections of blocks No 3 and 4, and two more will be tapped from the connections of blocks No 5 and 6.

2. The above mentioned transformers are connected with a 6 kV layout with a busbar system divided into eleven sections and equipped with 200 MVA oil circuit-breakers.

3. The 220 V alternating current is used in the power station primarily for lighting, control and direction purposes.
4. The 220 V d.c. is used in the power station mainly for control and direction, for emergency lighting, and for some motors of key importance.

III. The Central Control Room

The control and direction of the power station operations is from the central control room, where are the panels and boards for instruments for measuring.

d/ <u>General description of the construction of the buildings</u>

The composition of the power station is a happy compromise which creates the impression of spacial freedom and logic of design, maintaining at the same time the economically desirable compactness of the structures and of the technological sequences.

The architectural design clearly singles out the character of basic technological sequences. Maintaining the general harmony of the composition, the following sequences can be easily distinguished : the coal supply system, the cooling water system, the main building and the central control room. All designs are characterized by general use of pre-fabricated parts, which helped in eliminating labour-consuming "wet" processes and in completing relatively quickly the whole capital investment programme. The most labour consuming main building was designed as a four-nave structure in which the following sections are situated :

a/ coal containers

b/ the boiler house

c/ degassers

d/ the machine room.

The building is made of steel and prefabricated concrete blocks.

The degree of mechanization in erecting the main building - amounting to 86 per cent against 72 per cent for all other construction works - proves that the solution of the project was progressive. Ceilings, coal containers, inside walls and staircases were made as monolithic construction. The galleries and the elements of the coal supply system were made of prefabricated material.

Total weight of the equipment already installed for the 300 MW plant amount to 24000 tons.

## History of construction

The construction began in the first quarter of 1955. On March 3, 1955 the work on the foundations of the main building began. On October 16, the work on erecting the steel structure started, and in September 1956 the installation of equipment was commenced.

Other construction works on the remaining buildings, carried on at the same time, allowed for the possibility of installing in the future the equipment needed for a 500 MW power station.

On November 12, 1957, i.e. 33 months after the construction had started, the first 50 MW turbine was synchronized, and 4 weeks later, the second.

Since construction works were much advanced, the pace of equipment installation works had been speeded up, resulting in putting two 100 MW turbines into operation in 1958, ahead of scheduled time.

In this way a success without precedent in power station construction has been achieved. Putting into operation two 100 MW turbines has become not only a new achievement in construction work, but also created a new yardstich for the possibilities of our installation - construction works.

Within 45 weeks of the commencement of work power station reached the 300 MW capacity.

In the first half of 1959 the work on the expansion of the power station to 500 MW /decided upon in 1956/ was so far advanced that in the middle of July the installation of the next four boilers began, as well as of the next two 100 MW turbines which were scheduled for completion in the fourth quarter of 1960.

Construction works began on the orders of the Ministry of Mining and Power. A direct investor is the Skawina Power Station Construction Authority appointed and supervised by the Power Works of the Southern Region in Katowice. Their duties include : the working out of the assumptions, the supply of technical data and equipment, and financial control.

The work is being carried out by the Skawina Branch of the Kraków Establishment for Power Station and Industrial Construction. Their duties as general contractors include : the distribution of work among specialized establishments, working out directives, deciding about the organization of work and its co-ordination.

In order to complete the job on time the general contractors have engaged 12 specialized establishments. The distribution of work is now as follows :

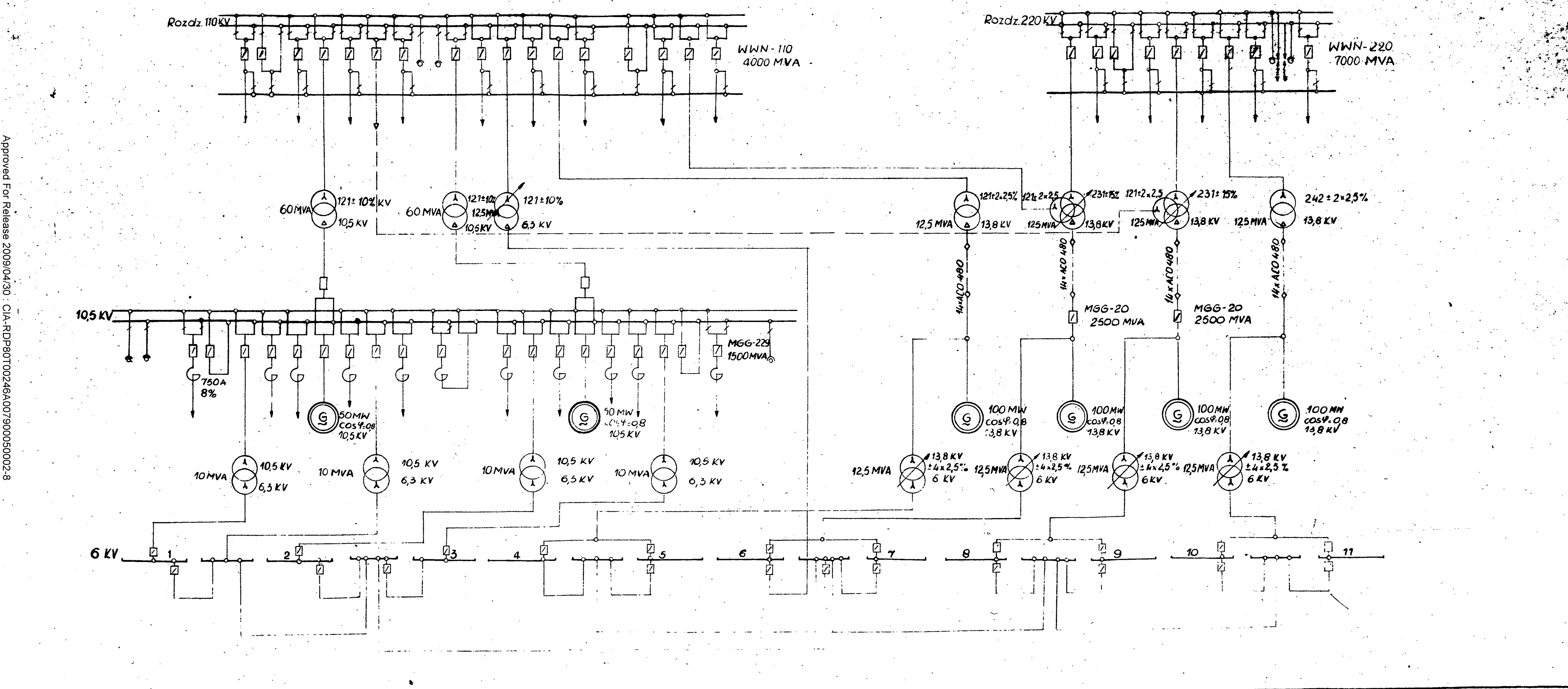
1. Construction work /roads, railways, sewage, general construction/ - by the general contractors: the Kraków Establishment for Power Station and Industrial Construction.
2. Steel construction - "Mostostal", Warsaw.
3. The installation of thermo-mechanical equipment - "Energomontaż", Katowice.

4. The installation of electrical equipment - "Elektrobudowa", Katowice.
5. Engineering and construction work on the water supply system - the Kraków Establishment for Hydro-Engineering Construction, Kraków
6. Insulation works - "Termoizolacja", Zabrze.
7. The installation of the automatic measuring and controlling equipment - "Energoaparatura", Katowice.

The realization of construction targets confirmed that work organization assumptions were right and provided the experience which will contribute to further improvements in the organization of construction works.

End of # 14

# Schemat elektryczny



# Schemat cieplny.